Lake Boren Water Quality

A Report on Water Quality Monitoring Results
for Water Year 2012

Lake Boren *Photo by KC Lake Stewardship Program*

Prepared for the City of Newcastle
by the King County Lakes and Streams Monitoring Group

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King County

THE CITY OF NEWCASTLE
1869 Washington 1994

OVERVIEW

The King County Lakes and Streams Monitoring (KCLSM) group and its predecessor the Lake Stewardship Program began working with volunteer monitors to monitor Lake Boren in 1994 and have continued to the present with gaps in 1995, 1996, and 2006. In 2005, the City of Newcastle began contracting with King County to fund the monitoring effort in Lake Boren, including monitoring of fecal coliform bacteria. The longer term water quality data indicate that currently the lake has moderate algae productivity (mesotrophic) with fairly good water quality.

Although there is no longer a trailer-accessible public access boat launch, there is a large park on the southwest shoreline of the lake where members of the public can launch small car-top boats and get into the water, as well as fish from a large dock. The Washington Department of Fish and Wildlife continues to stock the lake each year with approximately 1,000 8-12" rainbow trout.

Residents and lake users should keep a watch on aquatic plants growing near the shore to catch early infestations of Brazilian elodea or other noxious weeds. The lake is known to host a non-native tape grass (*Vallisneria americana*), which does not appear to be causing any major problems. Eurasian watermilfoil (*Myriophyllum spicatum*), which is legally defined as a noxious weed within the State of Washington, has also been identified in the lake and this should be monitored for spreading. Work has been done in previous years to control the water-lilies (*Nymphaea odorata*).

This report refers to two common measures used to predict water quality in lakes. The Trophic State Index or TSI (Carlson 1977) is a method of calculating indicators from collected data that allows comparison between different parameters and predicts the volume of algae present in the lake. A second measure is the nitrogen-to-phosphorus ratio (N:P), which is used to look at nutrient conditions for cyanobacterial success in the lake during certain periods. Both the TSI and N:P ratios have been calculated using the available data collected through the volunteer monitoring program.

The discussion in this report focuses on the 2012 water year. Specific water quality data used to generate the charts in this report can be downloaded from the King County Lake Stewardship data website at:

http://your.kingcounty.gov/dnrp/wlr/water-resources/small-lakes/data/default.aspx

Data can also be provided in the form of excel files upon request.

Physical Parameters

There was no Level I volunteer for the lake this year, so no daily lake levels or precipitation measurements were taken. Both Secchi transparency and water temperatures were measured during the Level II water sampling events that began in May and lasted through October.

Secchi transparency is a common method used to assess and compare water clarity. It is a measure of the water depth at which a black-and-white disk disappears from view when lowered from the water surface.

For Lake Boren, Secchi transparency values ranged from 3.5 m to 5.0 m, averaging 4.0 m (Figure 1). This puts Lake Boren in the mid-range of clarity for the King County small lakes monitored in 2012. It appears as if water clarity remained relatively stable throughout the spring and early summer and then increased in fall, with the highest clarity in late September and early October (note that the Y-axis is traditionally reversed on Secchi charts to mimic looking into the water).

Similar to data collected in previous years, the Secchi transparency values exhibited normal variability through the season. It is interesting to note that the clarity was best in fall when typically cyanobacterial blooms occur that reduce lake clarity. The last reading in October does have decreased clarity, which could suggest that an algae bloom began right at the tail end of the sampling season.

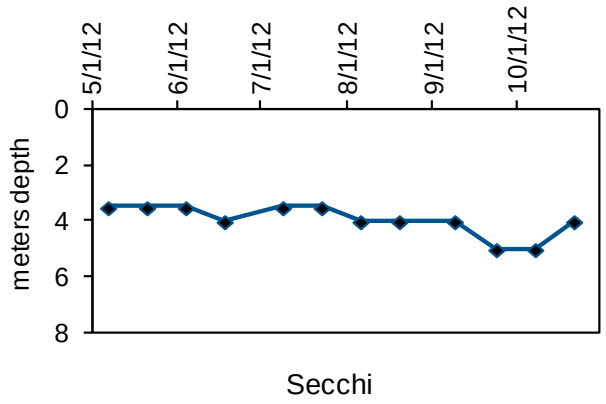

Figure 1. Lake Boren Secchi Transparency

Water temperatures during the May–October sampling period generally followed a pattern similar to other lakes in the region; a cool spring, but warming in summer with maximum temperatures occurring in early August, and then cooling in the fall (Figure 2). There was a small bump in water temperature in late September and this likely had to do with the very warm fall the region experienced. The 2012 weather pattern was much more typical of the Puget Sound Area, unlike 2011 which had a strong La Nina in effect.

The water temperature at Lake Boren ranged from 12.0 to 23.5 degrees Celsius with an average seasonal temperature of 17.7 degrees Celsius. Compared to other lakes monitored through the program, Lake Boren was in the mid range of summer temperature maxima for the epilimnion (upper layer of shallow water).

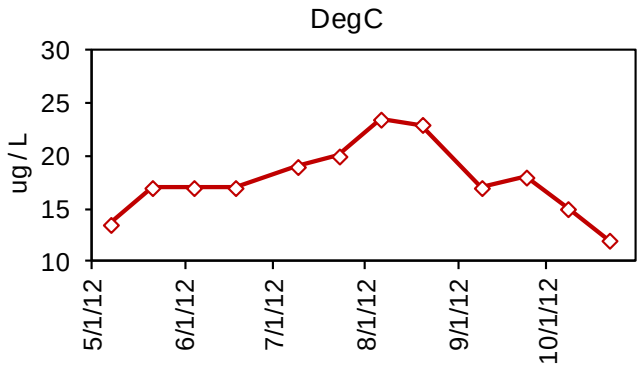

Figure 2. Lake Boren Water Temperatures

Figure 3 shows average May - October temperatures dating back to 1997, using data from the Level II monitoring season. The majority of the data was very consistent, but includes a period of increased temperatures from 2004 to 2009. Water temperatures dropped in 2010 - 2011, both of which had a La Nina weather pattern for the northwest. The year 2012 did have a more normal weather pattern, but there was no change in the seasonal average temperature for Lake Boren from the two previous years. At this point, no trend is being observed in the summer water temperatures of the lake.

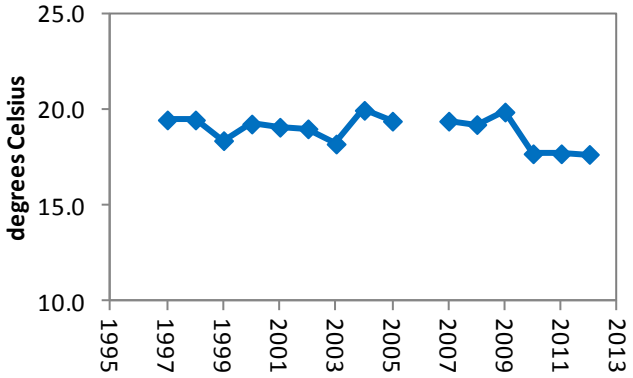

Figure 3. Lake Boren average water temperatures 1996 to 2012

Nutrient and Chlorophyll Analysis

Phosphorus and **nitrogen** are naturally occurring elements that are necessary in small amounts for both plants and animals for healthy growth and reproduction. However, many actions associated with urban development can increase concentrations of these nutrients beyond natural levels. In lakes of the Puget Sound lowlands, phosphorus is often the nutrient in least supply, meaning that biological productivity is often limited by the amount of available phosphorus. Increases in phosphorus concentrations can lead to more frequent and denser algae blooms, which are a nuisance to residents and lake users, and a potential safety threat if blooms become dominated by species that can produce toxins.

Samples collected by volunteers are analyzed for total phosphorus (TP) and total nitrogen (TN) concentrations at one meter depth between May and October, with deeper water analyzed twice through the season in May and August.

TN decreased throughout the spring and early summer reaching its lowest point at the end of August and then increased slightly through the rest of the sampling season. TP remained steady through the spring and early summer and then increased in tandem with TN in the last sample at the end of October (Figure 4).

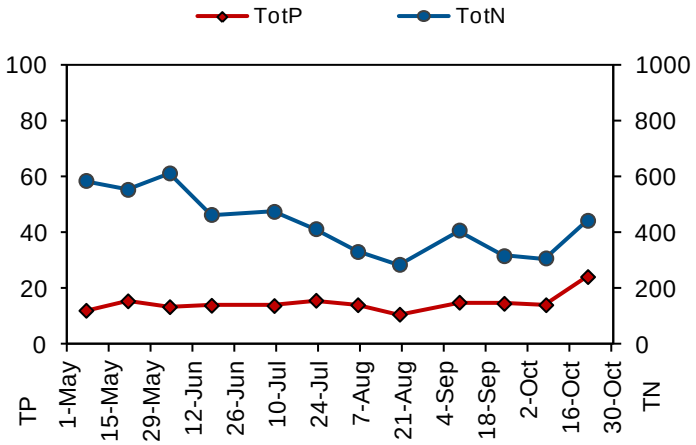

Figure 4. Lake Boren nutrients in ug/L

The ratio of TN to TP can be used to determine if conditions are favorable for the growth of cyanobacteria (bluegreen algae) that can impact beneficial uses of the lake. When N:P ratios are near or below 20-25, cyanobacteria can dominate the algal community due to their ability to take nitrogen from the air.

In 2012, the N:P ratio varied from 18.3 to 48.5 with an average of 30.3, which suggests conditions in the lake were near the threshold for favoring cyanobacteria (Figure 5). N:P ratios were somewhat unfavorable for bluegreens during the first half of the sampling season, but by August ratios were consistently near 25, which indicated nutrient conditions were improving for cyanobacteria in late summer through fall.

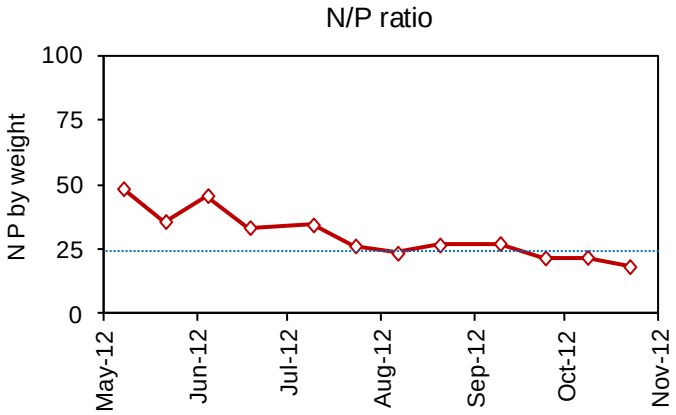

Figure 5: 2012 Boren N:P ratios, Values below the blue line indicate a potential nutrient advantage for cyanobacteria.

Chlorophyll *a* values were fairly low throughout the spring and early summer at Lake Boren (Figure 6), increasing slightly in late July to a relatively stable level through the rest of the season.

Pheophytin, which is degraded chlorophyll, remained near the level of analytical detection throughout the season.

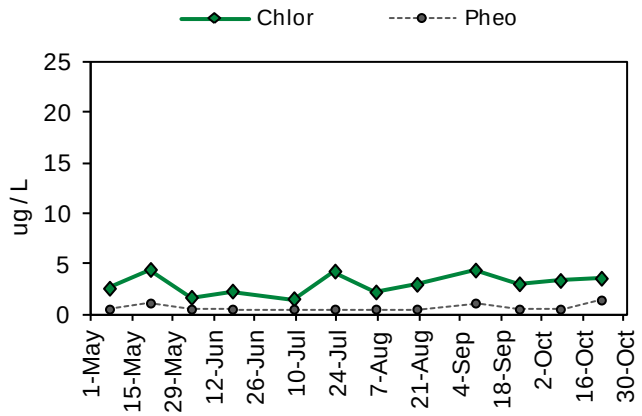

Figure 6. Lake Boren Chlorophyll *a* and Pheophytin Concentrations

Water column profiles

The deep water temperatures during the first profile event suggested the lake was thermally stratified, and it remained so in late August (Table 1). Total phosphorus was slightly elevated in the deep water during May, but had increased markedly by August, suggesting that the lake was anoxic in the bottom water. Total nitrogen did not change very much between May and August in the deep water, although the surface value in August seems low relative to other values. The OPO4 (orthophosphate) values are high enough in the deep water during August to suggest that phosphorus release from the sediments to the water was significant in the summer, and the anoxic conditions are further confirmed by the presence of increased amounts of ammonia (NH3. An increase in Chlorophyll *a* and nutrients in the August mid-depth sample suggests that enough light was reaching the mid depths to stimulate growth of an algae population in water at or below the thermocline. This is a similar pattern to what has been seen in other years at Lake Boren.

Table 1. Lake Boren Profile Sample Analysis Results. Sample values below minimum detection level are marked <MDL.

Lake name	Date	Secchi	Depth	DegC	Chlor-a	Pheo	Total N	NH3	Total P	OPO4	UV254	Total Alk
Boren	5/21/12	3.5	1	17.0	4.43	1.1	0.555	0.014	0.0155	**0.002**	0.142	58.7
Boren			5	11.0	2.37	**0.5**	0.615		0.0123			
Boren			9	6.0	0.99	**0.5**	0.795	0.148	0.023	0.0026		
Boren	8/20/12	4.0	1	23.0	2.96	**0.5**	0.286	**0.005**	0.0107	**0.002**	0.095	65.2
Boren			5	16.0	21.4	2.7	0.719		0.0269			
Boren			9	7.0	4.67		0.786	0.522	0.0774	0.0461		

The values of the UV254 indicate that the water is relatively clear, with a little coloration from organic substances. The total alkalinity suggests that the water in the lake is less soft

than other urban area lakes and is better buffered from pH change than many regional lakes.

The Trophic State Index

A common method of tracking water quality trends in lakes is by calculating the "trophic state index" (TSI), developed by Robert Carlson in 1977. TSI indicators predict the biological productivity of the lake based on water clarity (Secchi) and measured concentrations of Total P and chlorophyll a. The Index relates to three categories of productivity:

- *oligotrophic* (low productivity, below 40 on the TSI scale - low in nutrient concentrations, small amount of algae growth);
- *mesotrophic* (moderate productivity, between 40 and 50 on TSI scale – moderate nutrient concentrations, moderate growth of algae growth); and
- *eutrophic* (high productivity, above 50 – high nutrient concentrations, high level of algae growth).

In Lake Boren, all of the 2012 TSI indicators were close together, placing the lake in the low mesotrophic range, similar to 2011 (Figure 7). The indicators suggest that the lake has been relatively stable over time in terms of nutrient concentrations, with some year to year variability. A trend line is added to the annual TSI values, produces a low correlation coefficient for the regression, suggesting that a trend does not explain most of the variation from year to year.

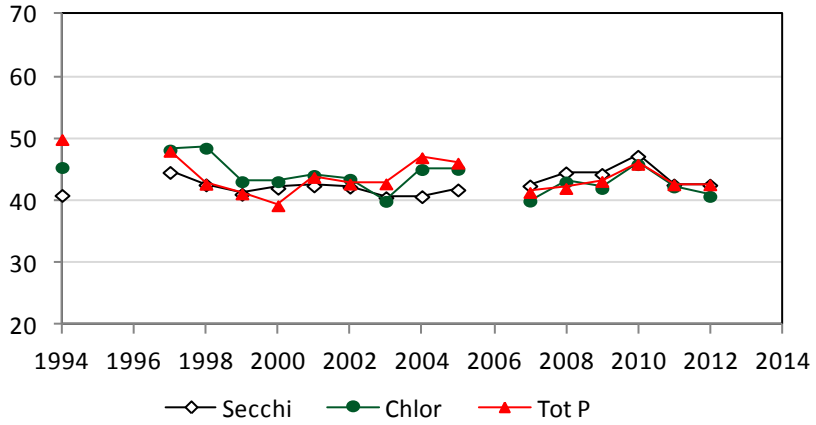

Figure 7. TSI Values at Lake Boren

Conclusions and Recommendations

Based on monitoring data, water quality in Lake Boren has been relatively stable over the last decade. In 2012, nutrient concentrations varied little through the monitoring season until phosphorus increased relative to nitrogen in the fall, resulting in lower N:P ratios. This indicates that nutrient conditions could have favored nuisance bluegreen algae blooms in late summer through fall.

Validation is weak for a trend line drawn through the combined TSI values over time. Continued monitoring of nutrient and chlorophyll *a* concentrations to assess conditions annually would determine whether or not stability is being maintained long term. Future algae blooms should be reported for evaluation by the Washington State Department of Ecology's Toxic Algae Monitoring Program to determine whether or not blooms at the lake may be producing toxins.

The City of Newcastle also has contracted with KCLSMs to perform fecal coliform analysis in addition to bimonthly monitoring during May through October, and this year an additional survey was included for stations along China Creek, the main inlet to lake Boren. A separate summary report has been written discussing the results and conclusions of those efforts.